AN ANAGRAM CLASSIFICATION SYSTEM

A. ROSS ECKLER
Morristown, New Jersey

Anagramming -- the transformation of one word into another by rearrangement of its letters -- is one of the oldest forms of word play, dating back hundreds of years. It is somewhat surprising that no one has attempted a systematic classification of anagrams. Allan R. Ball's The Nuttall Dictionary of Anagrams (Frederick Warne, 1937) lists approximately ten thousand words which can be anagrammed into other words, but it does not point out that the number of essentially different anagrams is far smaller. For example, the transformation of PROSE into SPORE is exactly the same as the transformation of OLIVE into VOILE -- both can be represented by means of the transformation abcde - dacbe (to save space, one can simply write this transformation as dacbe, understanding that one starts with the letters in lexicographic order). In fact, there are exactly 119 ways in which the letters abcde can be rearranged; in general, a word of n letters can be arranged in exactly $n(n-1)(n-2)\cdots\cdots 2\cdot 1 - 1 = (n!) - 1$ different ways.

Can these transformations be arranged in a systematic fashion? Mathematicians tell us that any transformation of the type described above can be broken down into a number of non-overlapping cyclic permutations of letters. For example, in the transformation dacbe, the letters c and e do not change their positions in the word, and the letter a is replaced by d, the letter d is replaced by b, and the letter b is replaced by a. In other words, the transformation dacbe consists of two cyclic permutations of length one (the letter c and the letter e permute into themselves), and one cyclic permutation of length three (the letters d, b and a). Similarly, the transformation baecd consists of one cyclic permutation of length two (the letters b and a), and one cyclic permutation of length three (the letters e, c and d). The first transformation can be identified as a (1)(1)(3)-anagram, and the second as a (2)(3)-anagram. For words of five letters, there are 10 different (1)(1)(1)(2)-anagrams, 15 different (1)(2)(2)-anagrams, 20 different (1)(1)(3)-anagrams, 20 different (2)(3)-anagrams, 30 different (1)(4)-anagrams, and 24 different (5)-anagrams.

Can examples be found for all these anagrams? The reader should note that the transformation of PROSE into SPORE yields the dacbe anagram, but the transformation of SPORE into PROSE yields the bdcae anagram -- in other words, one obtains two distinct anagrams from a single example. However, this is not always the case; the transformation of CORAL into CAROL is the same as the transformation of CAROL into CORAL; both yield the adcbe anagram. If no cycle in the transformation is longer than two, only one distinct anagram results. In order that the anagrams be unambiguously illustrated, it is necessary to insist that all words have no repeated letters.

The following table lists one or two examples for each of the 119 possible transformations of five-letter words into other five-letter words. Whenever an example yields two distinct anagrams, they are listed next to each other.

(1)(1)(1)(2)-anagrams

abced	PARSE-PARES, ANGEL-ANGLE
abdce	TRAIL-TRIAL, UNITE-UNTIE
abedc	CARET-CATER, MOLAR-MORAL
acbde	CRAVE-CARVE, DAIRY-DIARY
adcbe	SLATE-STALE, ABODE-ADOBE
aecdb	SPRAT-STRAP
bacde	ARISE-RAISE, AMPLE-MAPLE
cbade	MATES-TAMES, MELON-LEMON
dbcae	CRATE-TRACE, PEARS-REAPS
ebcda	AURIC-CURIA, ERUCT-TRUCE

(1)(2)(2)-anagrams

acbed	BALER-BLARE, CARET-CRATE
adebc	TALON-TONAL, BELOW-BOWEL
aedcb	PLANE-PENAL, FERAL-FLARE
baced	LUCRE-ULCER
badce	AMEND-MANED
baedc	INERT-NITRE
cbaed	PARSE-RAPES, PALES-LAPSE
cdabe	AMBLE-BLAME, ASCOT-COAST
ceadb	CRUEL-ULCER
dbeac	EARLY-LAYER
dcbae	PARTS-TRAPS, CIVET-EVICT
decab	LEAST-STALE
ebdca	EOSIN-NOISE
ecbda	TONUS-SNOUT
edcba	PARTS-STRAP, REBUT-TUBER

(1)(1)(3)-anagrams

abdec-abecd	STEAL-STALE, CHAIN-CHINA
acdbe-adbce	BROAD-BOARD, PEALS-PALES-PLEAS
acedb-aebdc	PLEAD-PEDAL
adceb-aecbd	CEDAR-CADRE
bcade-cabde	BRAID-RABID, SPATE-PASTE
bdcae-dacbe	SCALP-CLASP, SPORE-PROSE
becda-eacdb	SPARE-PEARS, TRACE-REACT
cbdae-dbace	ARGON-GROAN
cbeda-ebadc	SABER-BARES, DOZEN-ZONED
dbcea-ebcad	GROWN-WRONG, TRUCE-CRUET

(2)(3)-anagrams

badec-baecd	NITER-INERT, VOTER-OVERT
bcaed-cabed	GLARE-LAGER, STARE-ASTER
bdeac-daebc	SPEAR-PARSE, OCEAN-CANOE
bedca-eadcb	CHIME-HEMIC, SPINE-PENIS
cdaeb-ceabd	TRINE-INTER, STONE-ONSET
cdeba-edabc	TABLE-BLEAT, RELAY-LAYER
cedab-deacb	AMBER-BREAM, ANGEL-GLEAN
dcbea-ecbad	TRACE-CARET, SLATE-TALES
dceab-debac	EXALT-LATEX, BEAMY-MAYBE
ecdba-edbca	STEAM-MEATS, SPRAT-TRAPS

(1)(4)-anagrams

acdeb-aebcd	LEAPS-LAPSE, BEAST-BASTE
acebd-adbec	SATYR-STRAY
adecb-aedbc	SLATE-STEAL, BREAK-BAKER
bcdae-dabce	SPARE-PARSE, NAMED-AMEND
bceda-eabdc	SPIEL-PILES
bdace-cadbe	BARMY-AMBRY, KNEAD-NAKED
bdcea-eacbd	SPRAT-PARTS, SCARP-CRAPS
beadc-caedb	PANES-ASPEN
becad-daceb	SLATE-LEAST
cbdea-ebacd	DEBAR-BEARD, DIVAN-VIAND
cbead-dbaec	SIREN-RINSE, SOWER-WORSE
cdbae-dcabe	MATES-TEAMS, RAPES-PEARS
cebda-ecadb	DEBAR-BREAD, FIBER-BRIEF
dbeca-ebdac	LEARN-RENAL
decba-edcab	SPARE-REAPS, LAPSE-SEPAL

(5)-anagrams

bcdea-eabcd	STALE-TALES, STRAP-TRAPS
bcead-dabec	SHOER-HORSE, OTHER-THROE
bdaec-caebd	PLEAS-LAPSE, SWEAT-WASTE
bdeca-eadbc	STEAL-TALES, SPEAR-PARES
beacd-cadeb	BRUTE-REBUT, ISLET-STILE
bedac-daecb	AILED-IDEAL
cdbea-ecabd	TALES-LEAST, FIBRE-BRIEF
cdeab-deabc	ANGLE-GLEAN, ELBOW-BOWEL
cebad-dcaeb	PARSE-REAPS, CATER-TRACE
cedba-edacb	LARGE-REGAL
dceba-edbac	REACT-CATER, RUNIC-INCUR
debca-ecdab	NORTH-THORN, PEACH-CHEAP

Dmitri Borgmann, in his Language on Vacation (Scribner's, 1965), has suggested names for several of these anagrams. The (5)-anagrams bcdea, cdeab, deabc and eabcd are all cyclic transposals; the (1)(2)(2)-anagram edcba is a reversal; the (1)(1)(3)-anagrams adbce and acdbe are anchored transposals; and the (1)(1)(1)(2)-anagrams abedc, adcbe, cbade, aecdb, dbcae and ebcda are metalleges (the switch of two non-adjacent letters in a word). If one extends the definition of metallege to include the switch of two adjacent letters, then the (1)(1)(1)(2)-anagrams abced, abdce, acbde and bacde are added; if one extends the definition of metallege to include the switch of three non-adjacent letters, the (1)(1)(3)-anagrams ebadc and cbeda are added.

The construction of an analogous table of examples for six-letter anagrams is a far more ambitious task -- it is necessary to find examples for 719 anagrams. As a start on this task, the table below provides examples for 100 of the 120 possible (6)-anagrams, the ones of greatest logological interest. All examples can be found in either Webster's Unabridged Dictionary (3rd edition) or the Oxford English Dictionary. The reader is invited to try and fill in the blanks, not an easy task.

bcdefa-fabcde	STABLE-TABLES
bcdfae-eabcfd	SPRITE-PRIEST
bceafd-dabfce	
bcefda-fabecd	CATION-ATONIC, PUNISH-UNSHIP
bcfade-dabefc	PLIERS-LISPER
bcfead-eabfdc	TINSEL-INLETS
bdaefc-cafbde	REGAIN-EARING, STRAKE-TASKER
bdafce-caebfd	PLEADS-LAPSED, ALTERN-LEARNT
bdecfa-fadbce	SCALER-CLEARS
bdefac-eafbcd	ENRICH-NICHER, UPROSE-POSEUR

bdfcae-eadbfc	SPIREA-PRAISE
bdfeca-faebdc	
beacfd-cadfbe	CRATES-RECAST
beafdc-cafebd	STREAK-TASKER
bedafc-dafcbe	
bedfca-faecbd	THORAL-HARLOT
befacd-daefbc	PHENOL-HOLPEN, CRAPED-REDCAP
befcda-fadebc	SCATHE-CHEATS, SCARED-CEDARS
bfacde-cadefb	WHINGE-HEWING, BOATER-ORBATE
bfaecd-caefdb	ASCENT-STANCE
bfdace-daecfb	
bfdeac-eafcdb	
bfeadc-dafecb	AISLED-IDEALS, SPLINE-PENSIL
bfecad-eadfcb	
cdbefa-fcabde	SLIDER-IDLERS, SLOWER-OWLERS
cdbfae-ecabfd	SPRITE-RIPEST, VASTER-STARVE
cdeafb-dfabce	VELOUR-LOUVRE
cdefba-feabcd	DEPART-PARTED, LAMENT-MENTAL
cdfabe-deabfc	CAMELS-MESCAL, HOUNDS-UNSHOD
cdfeab-efabdc	ALCOVE-COEVAL, DEACON-ACNODE
cebafd-dcafbe	
cebfda-fcaebd	LADIES-DEASIL
cedbfa-fdacbe	SERVAL-RAVELS, TURBOS-ROBUST
cedfab-efacbd	AMBLED-BELDAM, TOPERS-PRESTO
cefadb-dfaebc	BETRIM-TIMBRE, ESCROW-COWERS
cefbad-edafbc	CARTED-REDACT, LAPSED-PEDALS
cfbade-dcaefb	OLEINS-ESLOIN
cfbead-ecafdb	
cfdbae-edacfb	
cfdeba-feacdb	REBATO-BOATER, SLATER-ARTELS
cfeabd-deafcb	RECTAL-CLARET
cfebda-fdaecb	SAILED-IDEALS, SACKER-CREAKS
dcebfa-fdbace	SNIPED-PIENDS
dcefab-efbacd	STAPLE-PALEST, STARVE-RAVEST
dcfbae-edbafc	LIRATE-TAILER, RELAND-ALDERN
dcfeba-febadc	REACTS-CASTER
debcfa-fcdabe	TREPAN-PARENT, DONATE-ATONED
debfac-ecfabd	
defbca-fdeabc	PROBED-BEDROP, SERANG-ANGERS
defcab-efdabc	ARMFUL-FULMAR, TEAING-INGATE
dfbcae-ecdafb	CANTER-TRANCE, LIFTER-TRIFLE
dfbeca-fceadb	SANTIR-TRAINS
dfebac-edfacb	DISBAR-BRAIDS
dfecba-fedacb	STAGER-GREATS
ecdfba-febcad	MANGER-ENGRAM, RENTAL-ANTLER
ecfbda-fdbeac	TINSEL-ENLIST
edbfca-fcebad	SCRAPE-PACERS, STROVE-VOTERS

edfcba-fedbac RELUCT-CUTLER, RETOPS-POSTER
efbcda-fcdeab DIVEST-STIVED, RAGEST-STAGER
efdbca-fdecab DEARTH-THREAD

What is the longest (n)-anagram for which an example having no repeated letters can be found? Turning to Language on Vacation, one finds the ten-letter example PLASTERING-REPLATINGS, and the eleven-letter example CLIDOSTERNA-DECLINATORS. An eleven-letter cyclic transposal is given by SPECULATION-PECULATIONS. Can the reader think of longer examples?

QUERY

Take four ordinary dice and inscribe the 24 faces with 24 different letters of the alphabet (omit, say, Q and Z). If the dice are rolled out on a table, there is a certain probability that the four upper faces can be rearranged to form a word. How should the 24 letters be placed on the dice in order to (1) minimize, or (2) maximize the probability that a word can be formed? How does one maximize this probability if one is not restricted to 24 different letters (that is, can repeat letters)? This problem is related to Word Chess but appears to be more difficult.